

carrying out step S2 over a larger area. After this Si deep etching is stopped, this residual layer, which can also have a thickness greater than the 30 µm indicated above, is again suitably structured (with or without a thin metallic sacrificial layer), and so forth. This can in principle be repeated a number of times (steps S2-i, i = 1 ... n) in order to generate increasingly more complex intermediate supports. However, it is preferably for the reasons already mentioned if a residual layer 5 always remains before the formation of pores 6 and is not removed until the end.

Because of the particular strength of an SiC membrane layer a membrane with pore diameters < 0.4 µm can be produced more simply and with good yield in approximately the same aspect ratio (instead of 0.45 µm pore diameter: 0.80 µm membrane thickness, for example 0.2 µm (or smaller): 0.4 µm (or smaller)).

Because of the good strength of an SiC membrane layer in some cases it is possible to omit the residual layer 5 in step S2, since the high-strength SiC layer can accept the stresses that arise in pore etching without damage. In this case S4 is omitted, which makes the method for producing a filter element simpler, shorter and cheaper.

Claims

1. A method for producing a filter element involving the following steps:
 S1) application of a membrane layer to a carrier substrate,
 S2) etching a membrane chamber on the side of the carrier substrate opposite the membrane layer, so that a residual layer of the carrier substrate still remains,
 S3) producing pores in the membrane layer by means of a lithographic and etching process in order to create a perforated membrane,
 S4) removal of the residual layer by etching in order to expose the membrane layer,
 S5) the membrane layer is subjected to an additional treatment to increase the mechanical strength during step S1 or in a subsequent step.
2. A method as in Claim 1, which is characterized by the fact that the treated membrane layer has a crystalline fraction of at least 25%.
3. A method as in Claim 1, which is characterized by the fact that a membrane layer is applied to a carrier substrate by means of a chemical vapor deposition process (CVD process).
4. A method as in Claim 1, which is characterized by the fact that a membrane layer is applied to a carrier substrate by means of a physical vapor deposition process (PVD process).
5. A method as in one of the preceding claims, which is characterized by the fact that the membrane layer consists of a ceramic material.
6. A method as in Claim 5, which is characterized by the fact that the membrane layer consists of a non-oxide ceramic.

7. A method as in Claim 6, which is characterized by the fact that the membrane layer consists of a nitride non-oxide ceramic.

8. A method as in Claim 7, which is characterized by the fact that the membrane layer consists of Si_3N_4 .

9. A method as in Claim 6, which is characterized by the fact that the membrane layer consists of a carbide non-oxide ceramic.

10. A method as in Claim 9, which is characterized by the fact that the membrane layer consists of SiC .

11. A method as in Claim 1, which is characterized by the fact that crystal nuclei are already generated in the membrane layer in step S1.

12. A method as in Claim 1, which is characterized by the fact that the structure of carrier layer and membrane layer is subjected to a temperature treatment (in particular heated) in order to increase the crystalline fraction in the membrane layer.

13. A method as in Claim 1 and/or Claim 12, which is characterized by the fact that in step S5 the structure of carrier layer and membrane layer is isostatically hot-pressed in order to increase the crystalline in the membrane layer.

14. A method as in one of the preceding claims, which is characterized by the fact that in step S1 or S5 the membrane layer is given an internal prestress.

15. A method as in one of the preceding claims, which is characterized by the fact that the treatment to increase the permissible mechanical load is a temperature treatment that is carried out by holding the membrane layer in a temperature range from about 200°C up to 2000°C at a process pressure of about 5-100 Pa.

16. A method as in one of the preceding claims, which is characterized by the fact that the temperature treatment step is a sintering at temperatures over about 900°C.

17. A method as in one of the preceding claims, which is characterized by the fact that the temperature treatment is carried out by means of electromagnetic radiation in the radiowave or microwave range.

18. A method as in Claim 17, which is characterized by the fact that the microwave radiation lies in the frequency range above 25 GHz, preferably in a frequency range at which the material of the membrane layer has a peak in its absorption curve.

19. A method as in Claim 13, which is characterized by the fact that the temperature treatment step includes an isostatic hot pressing at temperatures above about 750°C and pressures above about 100 bar.

20. A method as in Claim 13 and/or Claim 19, which is characterized by the fact that the isostatic hot pressing step is carried out prior to step S3 as in Claim 1.

21. A method as in Claim 1, which is characterized by the fact that the membrane layer is protected against etching agents after step S3 as in Claim 1.

22. A method as in Claim 21, which is characterized by the fact that the membrane is protected by a solid masking.

23. A method as in Claim 21, which is characterized by the fact that the membrane layer is protected by a coating material that is again removed after step S4 of Claim 1.

24. A filter element with a membrane layer (1) and a carrier layer (2), where the membrane layer (1) has a plurality of perforations (6), which is characterized by the fact that in the carrier layer (2) a membrane chamber (3) is exposed, the membrane layer (1) spans over the membrane chamber (3) and the membrane layer (1) has a compacted and/or at least partially crystalline structure with strength that has been increased over that of the starting material.

25. A filter element as in Claim 24, which is characterized by the fact that the increased strength of the membrane layer (1) is produced through an internal mechanical prestress.

26. A filter element as in Claim 24, which is characterized by the fact that the membrane layer (1) has microcrystalline and/or nanocrystalline structures and/or has been compacted.

27. A filter element as in one of Claims 24-26, which is characterized by the fact that the carrier substrate (2) has a plurality of membrane chambers (3), each of which is spanned over by one and the same membrane layer (1).

28. A filter element as in one of Claims 24-27, which is characterized by the fact that the membrane chamber (3) is rectangular in plan view.

29. A filter element as in Claim 28, which is characterized by the fact that the membrane chamber (3) in plan view has the shape of a slot, whose length is at least twice its width.

30. A filter element as in one of Claims 24-29, which is characterized by the fact that two oppositely lying sides (4) of the membrane chamber (3) run at an angle of less than 90° to the plane of the membrane.

31. A filter element as in one of Claims 24-30, which is characterized by the fact that the pore ratio of the thickness D of the membrane and pore diameter P the following relationship is valid: $0.01 < D/P < 100$, where the following applies for the thickness D of the membrane: $0.01 \mu\text{m} < D < 100 \mu\text{m}$.

32. A filter element as in one of Claims 24-31, which is characterized by the fact that the pores are essentially circular in shape and have a diameter in the range between $0.01 \mu\text{m}$ and $100 \mu\text{m}$.

33. A filter element as in one of Claims 24-32, which is characterized by the fact that the membrane layer (1), on the side turned toward the membrane chamber (3), lies on at least one intermediate support (8), the thickness of which is less than the thickness of the carrier substrate.

34. A filter element as in one of Claims 24-33, which is characterized by the fact that the membrane chamber (3) essentially extends over the entire area of the filter element.

35. A filter element as in one of Claims 24-34, which is characterized by the fact that the carrier substrate is chosen from the group of the following substances: Si, SiC, titanium oxides and other titanium compounds, magnesium oxide, zirconium oxide, nickel, chromium, Ni-chromium compounds, Al_2O_3 , yttrium compounds, and that the membrane layer consists of Si_3N_4 , SiC, a combination of the two substances or another silicon ceramic.